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INCH-POUND

MIL-DTL-12560K (MR)
7 December 2013

SUPERSEDING
MIL-DTL-12560J (MR)
24 July 2009

DETAIL SPECIFICATION

ARMOR PLATE, STEEL, WROUGHT, HOMOGENEOUS (FOR USE IN COMBAT-VEHICLES AND FOR AMMUNITION TESTING)

This specification is approved for use by the Department of the Army and is available for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 Scope. This specification covers wrought-steel homogeneous armor plate for ordered thicknesses from 0.098 inch (2.5 mm) up to an ordered thickness of 6.000 inches (152.4 mm), inclusive, for use in combat-vehicles and for ordered thicknesses from 0.250 inches (6.35 mm) up to an ordered thickness of 12.000 inches (304.8 mm), inclusive, for use in proof and acceptance testing of armor defeating ammunition (see 6.1, 6.2, and 6.3.3).

1.1.1 Cross-application. Plates produced to this revision can be used where previous revisions are specified. Revision K plates can be used where drawings call for prior revisions.

1.2 Classification. Wrought armor should be of the following classes as specified (see 6.2).

1.2.1 Class 1. Wrought armor plate with an ordered thickness of 0.098 to 6.000 inches (2.5 to 152.4 mm) which is heat treated to develop maximum resistance to penetration (see 6.1.1).

Comments, suggestions, or questions on this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Materials and Manufacturing Technology Branch, Specifications and Standards Office, Attn: RDRL-WMM-D, Aberdeen Proving Ground, MD 21005-5069 or emailed to richard.j.squillacioti.civ@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil/.

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1.2.2 Class 2. Wrought armor plate with an ordered thickness of 0.098 to 2.000 inches (2.5 to 50.8mm) which is heat treated to develop maximum resistance to shock (see 6.1.2).

1.2.3 Class 3. Wrought armor plate with an ordered thickness of 0.250 to 12.000 inches (6.35 to 304.8 mm) which is heat treated to develop specific hardness and impact values for evaluation of armor-defeating ammunition only. This class of armor is not intended for use in combat-vehicles. To meet the thickness tolerances of this class of armor special surface finishing may be required (see 6.1.3).

1.2.4 Class 4a. Wrought armor plate with an ordered thickness of 0.098 to 2.750 inches (2.5 to 69.9 mm) which is designed for better resistance to penetration with respect to Class 1 (see 6.1.4)

1.2.5 Class 4b. Wrought armor plate that is air hardened and auto-tempered with an ordered thickness of 0.098 to 2.750 inches (2.5 to 69.9 mm) which is designed for better resistance to penetration with respect to Class 1 (see 6.1.5)

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INTERNATIONAL STANDARDIZATION AGREEMENTS

ISO 9712	-	Non-Destructive Testing - Qualification and Certification of NDT Personnel

(Copies of this document are available from http://www.iso.ch or from the International Organization for Standardization American National Standards Institute 11 West 42nd Street, 13th Floor New York, New York, United States, 10036.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129	-	Military Marking for Shipment and Storage

(Copies of these documents are available online at http://quicksearch.dla.mil/ or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

USADTC TOP 2-2-710	-	Ballistic Tests of Armor Materials
ITOP 2-2-713	-	Ballistic Testing of Armor

(Application for copies is available online at http://www.dtic.mil/ or from the Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM A6/A6M	-	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling
ASTM A370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A578/ A578M	-	Standard Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications
ASTM A751	-	Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
ASTM E10	-	Standard Test Method for Brinell Hardness of Metallic Materials
ASTM E23	-	Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
ASTM E110	-	Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers
ASTM E290	-	Standard Test Methods for Bend Testing of Material for Ductility
ASTM E1077	-	Standard Test Methods for Estimating the Depth of Decarburization of Steel Specimens
ASTM E1444	-	Standard Practice for Magnetic Particle Testing

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. REQUIREMENTS

3.1 First Article. When specified in the contract or purchase order (see 6.2, 6.5 and 6.9), a sample or samples of the specified item shall be made available to the contracting officer or his authorized representative for approval in accordance with 4.4. The contractor shall comply with this requirement at the time of his first order or contract and at any time that the supplier has not furnished the same class of wrought armor plate in the applicable thickness range under this specification within a period of 37 months. The approval of the first article samples authorizes the commencement of shipment but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification, namely conformance or production acceptance. The first article samples and test plates shall be manufactured by the process proposed for use on production armor. This process shall be inspected by a cognizant government representative to ensure compliance with the details of this specification. The manufacturer's declared chemical analysis shall be submitted to the contracting agency and to the ballistic test agency. The ballistic test agency shall record the first article ballistic test plates submitted, showing the dates tested. Requests from the procuring activity to the ballistic test agency as to prior conformance with first article tests shall be accompanied by copies of the first article test firing records. Any deviation(s) noticed by the ballistic agency shall be brought to the attention of the contracting activity and to the manufacturer.

3.1.1 First time producer. First time producers wishing to qualify to this specification shall follow the instructions of 6.7.

3.2 Production acceptance.

3.2.1 Chemical composition. A declared chemistry shall be submitted to the contracting agency or its authorized representative and to the ballistic test agency. The chemical composition of the declared chemistry shall conform to the requirements of Table I, column A, unless otherwise specified in the contract or purchase order (see 6.2). If an analysis of Antimony, Arsenic or Lead is required, it shall be specified in the contract or purchase order (see 6.2). A single heat cannot be dual certified to both MIL-DTL-12560 and MIL-DTL-46100. The chemical composition shall be determined by a product analysis (values shall be listed as weight percent) in accordance with 4.6.1.1 and 4.8.1. The first article samples and the production test plates shall utilize the same declared chemistry within the allowable ranges proposed for use in production. A statement showing the heat analysis of each melt and one product analysis of each lot, complete details of the heat treatment, and all mechanical properties of each lot of production plates shall be furnished for the files of the purchaser at no cost. All elements of the chemical composition specified in Table I shall be shown in the statement. This statement shall be attached to the completed Rolled Homogeneous Armor Test Data Form (see Figure 1), or other certifications containing the same information.

3.2.2 Carbon equivalence. Carbon equivalence (CE) shall be calculated for each heat per ASTM A6/A6M, i.e.

$$CE = C + [Mn/6] + [(Cr + Mo + V)/5] + [(Ni + Cu)/15]$$

where the elements are expressed in wt%.

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TABLE I. Chemical composition and precision (product analysis) [6/].

ELEMENT	COLUMN A MAXIMUM LIMIT for DECLARED CHEMISTRY (WEIGHT PERCENT)	COLUMN B [5/] ALLOWABLE RANGE for FUTURE PRODUCTION LOTS (WEIGHT PERCENT)
Carbon	0.27 up to 2" thick, incl 0.29 over 2" up to 4" 0.31 over 4"	± 0.05
Manganese	NONE REQUIRED, HOWEVER IF: ≤ 1.00 > 1.00	 ± 0.15 ± 0.20
Phosphorus	0.020 [1/]	[4/]
Sulfur	0.010 [1/]	[4/]
Silicon	NONE REQUIRED, HOWEVER IF: ≤ 0.60 > 0.60 to ≤ 1.00 > 1.00	 ± 0.10 ± 0.15 ± 0.20
Nickel	NONE REQUIRED [3/]	± 0.25
Chromium	NONE REQUIRED, HOWEVER IF: ≤ 1.25 [3/] > 1.25	 ± 0.15 ± 0.25
Molybdenum	NONE REQUIRED, HOWEVER IF: ≤ 0.20 [3/] > 0.20	 ± 0.035 ± 0.075
Vanadium	NONE REQUIRED [3/]	± 0.05
Niobium	NONE REQUIRED [3/]	± 0.05
Boron	--- [2/]	[4/]
Copper	0.25 [3/]	[4/]
Nitrogen	0.03 [3/]	[4/]
Titanium	0.10 [3/]	[4/]
Aluminum	0.10 [3/]	[4/]
Lead	0.01 [3/]	[4/]
Tin	0.02 [3/]	[4/]

[1/] Phosphorus and sulfur total shall not exceed 0.020 wt%.

[2/] When the amount of boron is specified in the alloy, its content as determined by heat analysis shall not exceed 0.003 percent.

[3/] When the amount of an element is less than 0.02 percent the analysis may be reported as [< 0.02 wt%].

[4/] There are no limits on the allowable values for future lots; however, the values may not exceed those listed as the maximum limit.

[5/] Values are actual tolerance limits NOT percent tolerances.

[6/] Elements not listed in Table, but intentionally added, shall be reported.

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REQUEST FOR BALLISTIC TEST OF ROLLED HOMOGENEOUS ARMOR			
SPECIFICATION: MIL-DTL-12560	**REVISION: K**	**AMENDMENT:**	
FIRING RECORD:	**DATE:**	**TEST CONTRACT NO:**	

	PLATE/COIL MELTED	PLATE/COIL ROLLED	PLATE/COIL HEAT TREATED
Name:			
Address:			
POC:			
Phone No:			
Fax No:			

TEST ITEM IDENTIFICATION:		Ordered Thickness: _____
Lot No._____ Plate No. _____	RHA Classification CLASS: _____ Carbon Equivalence (CE):_____	Austenizing Temp:_____ Tempering Temp. _____
Bend Test:	Plate Thickness [Pass / Fail] 1)_____ 2)_____	Inside Radius 1)_____ 2)_____
PURPOSE: ___ Acceptance __ First Article ___ Reduced Testing		
SAMPLE: ___ Primary ___ Retest (Firing Record No. of Failed Sample_____)		

CHEMISTRY ANALYSIS	C	Mn	P	S	Si	Ni	Cr	Mo
FIRST ARTICLE RESULTS:								
PRODUCTION RESULTS:								
ACCEPTANCE (Pass / Fail)								

V:	Nb:	B:	N:		
Cu:	Ti:	Al:			

MECHANICAL PROPERTIES: **CHARPY IMPACT @ -40 Degs. F.** **Specimen Size:**

HARDNESS:	**LT Direction:1:_____ 2:_____ 3:_____**	**TL Direction:1:_____ 2:_____ 3:_____**

BALLISTIC TEST RESULTS: **SEPARATELY HEAT TREATED TEST PLATE : YES_____ NO_____**

Test:	**Obl. (deg)**	**Actual Thickness (in)**	**Required V_{50} (fps)**	**Actual V_{50} (fps)**	**Pass/ Fail**
Projectile:					
	NOTES:				

Lot [met] [failed to meet] the ballistic requirements of specification MIL-DTL-12560

Government Representative:	Date:	Supplier Representative:	Date:

FIGURE 1. Rolled Homogeneous Armor (RHA) Test Data Form

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3.2.2.1 Class 1 & 2. Class 1 and 2 steel shall have a CE of less than 0.80 wt% for plates less than 2 inches in thickness. For plates 2 to 4 inches shall have a CE of less than 0.85 wt%. For plates greater than 4 inches in thickness shall have a CE of 0.90 wt% or less.

3.2.2.2 Class 3. Class 3 steel shall have no CE limit unless otherwise specified in the contract or purchase order (see 6.2).

3.2.2.3 Class 4a. Class 4a steel shall have a CE limit of less than 0.70 wt% unless otherwise specified in the contract or purchase order (see 6.2).

3.2.2.4 Class 4b. Class 4b steel shall have no CE limit unless otherwise specified in the contract or purchase order (see 6.2).

3.2.3 Heat treatment. All plates in each lot, including samples, shall receive the same heat treatment except for such variations in tempering temperature as shall be necessary to produce the prescribed hardness. The austenitizing temperature for production plates may vary within a range of 50° above the temperature used for test plates, but in no case shall the plate surface exceed 1800°F (see 6.6).

3.2.4 Condition. Unless otherwise specified in the contract or purchase order (see 6.2), plates shall be in the as-heat treated condition. If descaling is required it shall be as specified in the contract or purchase order (see 6.2). Plates shall not be pickled.

3.2.5 Processing controls.

3.2.5.1 Furnace survey requirements of heat treating furnaces. All furnaces that are used to heat treat plates must be thermally surveyed. The initial survey is done once using the thinnest and thickest gage plate. This shall be followed with annual surveys using any gage.

3.2.5.1.1 Thermal survey requirements of heat treating furnaces. Thermal surveys are conducted as follows:

a. Three contact thermocouples must be used, both edges and in the middle across the width of the plate.
b. A calibrated recording device and thermocouples must be used.
c. The test plate is run through the furnace using standard hold times.
d. Trial starts when plate exits heat-up zones, and ends when plate exits furnace.
e. Maximum temperature variability when plate is in soaking zones is +/- 25°F for tempering furnaces and +/- 50°F for austenitizing furnaces.

3.2.5.2 Heating. Stress relieving the plates, local or general, shall be allowed after final quenching and tempering at a maximum temperature of 50°F below the tempering temperature. Plates shall not be stress relieved in a temperature range of 500-700°F. After stress relieving, the plates shall be tested for hardness and shall meet the requirements of Table II.

3.2.5.3 Repairing.

3.2.5.3.1 Weld repair of mill defects after final heat treatment. Unless otherwise specified in the contract or purchase order (see 6.2), weld repair after final heat treatment shall be permitted for

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plates with an ordered thickness greater than 2 inches. Mill imperfections may be repair welded by the contractor or referred to the contracting activity for acceptance with subsequent repair welding to be performed by the contracting activity. The following limitations shall apply to all weld repairs:

a. The total area to be repaired shall not exceed 0.1 percent of the surface of one side of the plate.
b. The depth of any area to be repaired shall not exceed one-tenth the ordered thickness of the plate or 1/4 inch, whichever is less. The depth of the area to be repaired shall be a minimum of 0.030 inch.
c. Maximum size of each weld repaired area is 0.375" diameter.
d. Areas to be welded shall be ground to assure that the welds are made on clean, sound metal.
e. After preparation for repair and prior to welding, the depressed area shall be magnetic particle inspected in accordance with ASTM E1444, and shown to be free of linear discontinuities.
f. Weld repairs shall be made in accordance with a welding procedure qualified in accordance with drawing 19207-12479550, entitled: "GROUND COMBAT VEHICLE WELDING CODE – STEEL" or MIL-HDBK-1941 or the applicable fabrication document.
g. Weld filler metal shall have a minimum UTS of 100 ksi.
h. The final repaired surface shall be ground smooth and flush with the adjacent surface. The finished weld surface shall also be free of under-fill.
i. Surface weld repairs shall be magnetic particle inspected after final grinding (or subsequent heat treatment, if applicable) in accordance with ASTM E1444. Welds and adjacent heat affected zone surfaces shall be free of relevant linear indications longer than 1/8 inch.
j. Repaired areas shall be marked. The markings shall remain legible and shall not be removed prior to performing all inspections specified herein.
k. Notation of such repaired areas and the type of welding filler metal used to make the weld repair(s) shall be made on the plate inspection form as part of the records.
l. If a non-heat treatable electrode is used, reheat treatment of the plate is prohibited.

TABLE II. Hardness requirements. (Inclusive).

Specified nominal thickness of plate, inches		Armor class	Brinell hardness range, HB
From	To and incl.		
0.098	0.249	1	360 - 410
0.250	0.624	1	340 - 390
0.625	1.125	1 & 3	330 - 380
1.126	1.999	1 & 3	310 - 360
2.000	3.999	1 & 3	270 - 320
4.000	6.000	1 & 3	250 - 300
6.001	9.000	3	230 - 280
9.001	12.00	3	210 - 260
0.098	2.000	2	260 - 310
0.098	2.750	4	420 - 470

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3.2.5.3.2 Weld repairs of mill defects prior to heat treatment. Unless otherwise specified in the contract or purchase order (see 6.2), weld repair prior to final heat treatment shall be permitted for plates with an ordered thickness greater than 0.250 inch. Weld repairs of mill imperfections may be accomplished prior to heat treatment within the limitations as specified in 3.2.5.3.1, except such weld repairs shall be made using a heat-treatable filler material.

3.2.5.4 Grinding. Grinding is not required but may be performed to remove minor defects not affecting the serviceability of the material provided that, unless otherwise authorized by the procuring activity, the grinding does not result in the reduction of the plate thickness in the ground area to less than the tolerances specified in Table III.

TABLE III. Thickness tolerances

SPECIFIED THICKNESS, INCHES		TOLERANCES OVER AND UNDER ORDERED THICKNESS FOR WIDTHS GIVEN, INCHES							
FROM	TO and INCLUDING	To 60	> 60 to 72	> 72 to 84	> 84 to 96	> 96 to 108	> 108 to 120	> 120 to 132	> 132 to 144
0.0980	**0.1249**	0.012	0.012	0.012	0.012	0.012	---	---	---
0.1250	**0.1874**	0.012	0.012	0.015	0.015	0.017	---	---	---
0.1875	**0.2499**	0.012	0.015	0.017	0.020	0.020	---	---	---
0.2500	**0.3749**	0.015	0.017	0.017	0.020	0.022	0.025	---	---
0.3750	**0.6249**	0.017	0.017	0.017	0.020	0.025	0.027	0.030	0.030
0.6250	**0.9990**	0.020	0.020	0.020	0.025	0.030	0.030	0.035	0.035
1.0000	**1.4990**	0.030	0.030	0.030	0.030	0.035	0.040	0.050	0.050
1.5000	**1.9990**	0.040	0.040	0.040	0.040	0.045	0.050	0.055	0.060
2.0000	**2.9990**	0.055	0.055	0.055	0.065	0.065	0.065	0.065	0.075
3.0000	**3.9990**	0.060	0.060	0.060	0.070	0.070	0.070	0.070	0.075
4.0000	**5.9990**	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.085
6.0000	**7.9990**	0.090	0.090	0.090	0.090	0.090	0.090	0.095	0.105
8.0000	**9.9990**	0.105	0.105	0.105	0.105	0.105	0.105	0.120	0.135
10.0000	**12.0000**	0.135	0.135	0.135	0.135	0.135	0.135	0.145	0.160

3.2.6 Mechanical properties.

3.2.6.1 Surface hardness. The surface hardness of each plate including first article samples shall be within the Brinell hardness range shown in Table II for the applicable class and thickness when tested in accordance with 4.8.2.

3.2.6.2 Impact. The Charpy V-notch impact test results of armor plate submitted shall meet the requirements shown in Table IV for the applicable hardness and thickness when tested in accordance with 4.8.3. The Charpy V-notch impact specimens shall be obtained both in the TL orientation (transverse to the major direction of rolling with the notch perpendicular to the plate surface so that the crack propagates in the longitudinal direction) and the LT orientation (longitudinal to the major direction of rolling with the notch perpendicular to the plate surface so that the crack propagates in the transverse direction).

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3.2.6.3 Bend test. Unless otherwise specified in the contract or purchase order (see 6.2), bend test samples shall be required for a given lot of plates with an ordered thickness of 0.500 inch and under, and shall be capable of being bent to the requirements specified in Table V without cracking (see 4.6.1.3, 4.6.2.4 and 4.8.4). For ordered thickness of greater than 0.500 inches a bend test shall be specified in the contract or purchase order (see 6.2). After bending, samples shall be free of cracks as determined by visual inspection unless otherwise specified in the contract or purchase order (see 6.2).

TABLE IV. Minimum Charpy V-notch impact requirements (at -40°F + 2°F)

Brinell hardness, BHN		Minimum impact values (average of three (3) test specimens), ft-lb			
		Specimen Size			
Inclusive	Exclusive	Standard	¾ width	½ width	¼ width
210	220	81	61	41	20
220	230	76	57	38	19
230	240	71	53	36	18
240	250	66	50	33	17
250	260	61	46	31	15
260	270	56	42	28	14
270	280	51	38	26	13
280	290	46	35	23	12
290	300	41	31	21	10
300	310	36	27	18	9
310	320	32	24	16	8
320	330	28	21	14	7
330	340	25	19	13	6
340	350	22	17	11	6
350	360	19	14	10	5
360	370	18	14	9	5
370	380	17	13	9	4
380	470	16	12	8	4

Table V. Bend test requirements.

Ordered Plate Thickness (T)	**Inside Radius**	
	Class 2	Class 1, 3 & 4
0.098 to 0. 500 inches, inclusive	3T	4T
Greater than 0.500 inches	as specified in contract or purchase order (see 6.2)	

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3.2.7 Ballistic requirements. Ballistic requirements shall be in accordance with the Appendix A of this specification. When a complete penetration cannot be obtained, the following rule shall be in effect until a new ballistic acceptance round can be utilized. When four (4) partial penetrations are above the minimum requirement for the specific thickness, the material shall be certified as acceptable with a V_{50} (which obviously cannot be specified) above the minimum requirement. There are no ballistic test requirements for class 2 plate thicker than 1.000 inch.

3.2.7.1 Ballistic test plate information. For each lot of armor plate a properly completed Rolled Homogeneous Armor (RHA) Test Data Form (see Figure 1) shall be submitted with each ballistic test plate that represents that particular processing lot.

3.2.8 Dimensions and tolerances.

3.2.8.1 Dimensions. Armor plates shall comply with the dimensions specified in the applicable drawings or in the contract or purchase order (see 6.2). Unless otherwise specified in the contract or order (see 6.2), dimensional tolerances will be in accordance with Table III. Armor plate tolerances on length and width dimensions shall be plus 2 inches and minus zero.

3.2.8.2 Thickness.

3.2.8.2.1 Thickness measurements (class 3 armor). The thickness of all class 3 plates shall be determined by measurements made one foot on centers over the entire surface of each plate. The measurements shall be to the nearest thousandth of an inch. The acceptance of each plate shall be based on these measurements meeting the thickness requirements of Table III.

3.2.8.2.2 Thickness tolerances. The thickness tolerances of each plate, after final treatment, shall be in accordance with Table III. The contract or purchase order (see 6.2) shall specify the thickness tolerance when not specified in Table III.

3.2.8.3 Flatness. Unless otherwise specified in the contract or order (see 6.2), the flatness tolerance of each plate shall be within one-half of the tolerance listed in ASTM A6/A6M (As of the release date of MIL-DTL-12560K (MR), the appropriate table is Table 14, however, this table may be re-numbered during a future revision or update, so caution should be taken by the user). Tighter tolerance requirements shall be specified in the contract or purchase order (see 6.2) and shall be as agreed upon between the contractor and the procuring activity.

3.2.8.4 Waviness. The permitted variation in waviness is a function of the permitted variation from a flat surface as obtained from Table 14 in ASTM A6/A6M. Unless otherwise specified in the contract or purchase order (see 6.2), the waviness tolerance of each plate shall be one-half the tolerance listed in ASTM A6/A6M Table 15, using the applicable full tolerance obtained from the flatness tolerance table (Table 14) for the appropriate plate thickness and width. The one-half tolerance reduction shall not be applied to both the flatness table and the waviness table to determine waviness tolerance. (As of the release date of MIL-DTL-12560K (MR), the appropriate table is Table 15, with reference to Table 14, however, these tables may be re-numbered during a future revision or update to ASTM A6/A6M, so caution should be taken by the user).

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3.2.9 Identification marking. Identification marking and records shall be such as to ensure positive identification of all plates, including test samples and specimens, with the lot and corresponding heat from which they were produced. The primary plate rolling direction shall be identified.

3.2.9.1 Class 3 armor plate identification marking. Manufacturers supplying class 3 armor plate are additionally required to:

a. Mark each class 3 plate with one foot square blocks showing thickness at the center of each block. The acceptance of each plate shall be based on these measurements meeting the thickness requirements set forth in Table III.

b. Label each plate "RHA, class 3, MIL-A-12560, plate No. ____, heat No.____." Labeling shall be approximately 1/2 inch high letters. Location of labeling for all plates shall be in the upper right hand corner.

3.2.9.2 Ballistic test plate identification marking. First article and acceptance ballistic test plates shall also be marked with unique melt and slab, the manufacture's name or trademark, the number and class of this specification, and the ordered plate thickness in inches. First article plates shall be marked "PRE," acceptance plates "ACC," and retest plates shall be marked "R1" and "R2." If a second set of retest plates are submitted they shall be marked "RR1" and "RR2." All plate markings shall be approximately 1/2 inch high letters and highlighted with a highly visible paint. The primary plate rolling direction shall be identified.

3.2.10 Information required. A statement showing the product analysis of each melt and complete details of the heat treatment of each lot shall be furnished for the files of the procuring activity in addition to the completed Rolled Homogeneous Armor (RHA) Test Data Form (see Figure 1). All elements of the chemical composition shall be shown in the statement, including special additives or hardening agents, whether shown in Table I or not.

3.2.11 Workmanship.

3.2.11.1 Surface imperfections. When specified in the contract or purchase order (see 6.2), plates shall be inspected for surface imperfections in the de-scaled condition, only. The top and bottom surface of each plate shall be free from the following surface defects: slivers, laps, checks, seams, blisters, snakes, cold shuts, cracks, burning, and laminations (see 6.3). Imperfections listed above which are of such nature as to affect the fabrication of the material, are rejectable.

3.2.11.1.1 Depth of imperfections. The depth of rolled-in scale, scale pitting, mechanical gouges, or snakes shall not exceed 0.015 inch and shall not reduce the steel thickness below the allowable minimum. Isolated individual pits over 0.015 inch deep and not within 6 inches of each other and which do not violate the minimum allowable thickness, as specified in Table III or the applicable drawings and fabrication documents, are acceptable. Additionally, if isolated individual pits do not lie within 4 feet of each other and have a depth of less than 4% of ordered gage, and less than 0.25 inch in diameter, are acceptable.

3.2.11.2 Edge preparation. Thermal cutting shall be permitted after final heat treatment provided the procedure, which may include grinding after thermal cutting, is such that no cracks develop

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on any thermally cut edge whether detected by nondestructive inspection, or as agreed upon in the contract. The heat affected zone of thermally cut plates (up to and including 1/2 inch in thickness) shall not exceed 1.2 times the plate's thickness from the cut edge. For plates over 1/2 inch thick, the heat affected zone shall not exceed 5/8 inch from the cut edge. In order to have the heat affected zone exceed these limits approval shall be obtained from the procuring activity and shall be as specified in the contract or purchase order (see 6.2). Supplier must demonstrate this capability to the procuring activity during First Article Testing.

3.2.11.3 Edge condition. Plate edge on plates delivered after heat treatment shall be free of cracks. The supplier shall practice such necessary process controls to prevent this condition.

3.2.11.4 Internal soundness. Ultrasonic testing is not required for plates with an ordered thickness that is less than or equal to 0.625 inch gauge. Plates over 0.625 inch must be ultrasonically tested unless supplier can prove substantial plates in the 0.626 to 2.00 inch gauge range have been ultrasonically tested in the past without findings. If supplier can demonstrate excellent internal soundness history, then only one plate from every lot with an ordered thickness between 0.626 and 2.000 inches shall be ultrasonically examined for internal soundness in accordance with 4.7.3. Every plate from every lot that has an ordered thickness greater than 2 inches shall be ultrasonically examined for internal soundness in accordance with 4.7.3. The acceptance level shall be C, unless otherwise specified in the contract or purchase order (see 6.2).

3.2.11.4.1 Acceptance criteria.

3.2.11.4.1.1 Single linear indications. In any four inches of length a single linear indication shall not exceed twice the plate thickness.

3.2.11.4.1.2 Multiple linear indications. Multiple linear indications shall not exceed 1-1/2 times the plate thickness if two or more lie in the same plane. The total length of indications in one plane, in any four inch length, shall not exceed twice the plate thickness. No more than ten indications, whether in one plane or multiple planes, are permitted in any four inch length.

3.2.11.4.1.3 Cracks. All cracks shall be rejectable (see 6.3.18 for definition).

3.2.11.4.1.4 Removal of large indications. Large indications shall be removed by the manufacturer or processor by grinding, or weld repair as specified in 3.2.5.3.

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.4).
b. Production acceptance inspection (see 4.5).

4.2 Testing responsibility and facilities. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all the requirements as specified herein. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor may use his own or any other facilities suitable for the performance of the

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requirements specified herein, except ballistic tests (see 4.2.1), unless disapproved by the Government. The Government reserves the right to perform or check any of the inspections set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements and to determine the validity of the certifications.

4.2.1 Ballistic testing facility. Unless otherwise specified in the contract or purchase order (see 6.2), the ballistic test plates shall be forwarded to the Commander, USA ATC, ATTN: TEDT-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059 or to an approved Government facility for ballistic testing for first article or production acceptance.

4.3 Lot. A lot shall consist of all production and ballistic test plates of the same melt of steel, of the same thickness, having the same treatment, and heat treated with the same thermal cycle in the same production furnace(s) in the same facility. When specified by the procuring activity (see 4.3.1 and 6.2), production and ballistic test plates shall be allowed to be heat treated separately. The test plate shall be heat treated in a production furnace.

4.3.1 Separately heat treated ballistic test plate. When the procuring activity allows a ballistic test plate to be heat treated separately from the production plates it represents (see 4.3), it shall be so stated in the data (see 6.6).

4.4 First article inspection. When required (see 6.2), the first article samples submitted in accordance with 3.1 shall be examined for all the provisions of this specification applicable to end item examination and shall utilize the same requirements and test methods as the production acceptance inspection shown in 4.5.

4.4.1 First article tests. First article tests shall consist of all the tests specified in 4.8.

4.4.2 First article ballistic test. Unless otherwise specified (see 3.1, 6.2, and 6.5), the first article ballistic test shall not be required provided (a) the manufacturer, within 37 months, has produced acceptable plates within the same nominal thickness ranges of Table VI, and (b) the production conditions are the same as for previously accepted plates. A supplier who has previously met the first article requirements shall furnish the procuring activity the firing record of the ballistic test plate and other pertinent data relative to compliance with first article. Neither first article nor acceptance ballistic tests shall be required for plates ordered to thicknesses of more than 6.25 inches. Acceptance of these thicker plates shall be based on meeting the other requirements of the specification.

4.5 Production acceptance inspection. The acceptance examination under 4.7 and the tests under 4.8 shall serve as a basis for the acceptance of individual production lots.

4.6 Sampling.

4.6.1 First article sampling.

4.6.1.1 Chemical composition. One sample for chemical analysis shall be taken from near each plate selected for the ballistic tests.

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TABLE VI. Ballistic test plate sizes and corresponding test projectiles for first article and acceptance testing.

Nominal thickness range, inches	Armor Class	Minimum size 1/ of test plates, inches	Test projectile and obliquity	TABLE
0.098 to 0.230 incl.	1 & 4	12 x 36	Cal .30 M2 Ball at 30°	A-I
0.231 to 0.624 incl.	1	12 x 36	Cal .30 M2 AP at 0°	A-II
0.250 to 0.624 incl.	3	12 x 36	Cal .30 M2 AP at 0°	A-II
0.625 to 1.125 incl.	1 & 3	12 x 36	Cal .50 M2 AP at 0°	A-III
1.126 to 2.750 incl.	1, 3 & 4	12 x 36	20 mm M602 APIT at 0°	A-IV
2.751 to 3.500 incl.	1 & 3	60 x 72	90 mm M82 APC at 45°	A-V
3.501 to 3.999 incl.	1 & 3	60 x72	90 mm M82 APC at 30°	A-VI
4.000 to 6.000 incl.	1 & 3	60 x 72	90 mm M318A1 AP at 0°	A-VII
Over 6.000 2/	3	---	---	---
0.098 to 0.249 incl.	2	12 x 36	Cal .30 FSP at 0°	A-VIII
0.250 to 0.499 incl.	2	12 x 36	Cal .50 FSP at 0°	A-IX
0.500 to 1.000 incl.	2	12 x 36	20 mm FSP at 0°	A-X
Over 1.000 2/	2	---	---	---
0.231 to 0.354 incl.	4	12 x 36	Cal .30 M2 AP at 30°	A-XI
0.355 to 0.590 incl.	4	12 x 36	Cal .50 M2 AP at 30°	A-XII
0.591 to 0.765 incl.	4	12 x 36	14.5 mm B32 API at 30°	A-XIII
0.766 to 1.125 incl.	4	12 x 36	14.5 mm BS41 API at 30°	A-XIV

1/ Other sizes may be submitted for the convenience of the manufacturer if approved by the Armor Vulnerability Division, USATC, Aberdeen Proving Ground.

2/ No ballistic test required.

4.6.1.2 Impact samples. At least one impact test sample shall be taken from near each submitted test plate in accordance with 4.8.3.1 or 4.8.3.2 and each shall consist of enough material for six impact specimens.

4.6.1.3 Bend test. Two bend test samples shall be tested in the transverse direction.

4.6.1.4 Decarburization. At least one decarburization test sample shall be taken on each plate selected for the ballistic tests for plates with an ordered thickness of 0.500 inch and less. Complete and partial decarburization shall be less than 0.017 inch when tested in accordance with ASTM E1077 (see 4.8.5).

4.6.1.5 Ultrasonic examination. Each submitted test plate greater than 0.625 inch in thickness shall be ultrasonically examined in accordance with 4.7.3.

4.6.1.6 Ballistic test plates. Two ballistic test plates for each nominal thickness range (see Table VI) shall be randomly selected and submitted for ballistic test. Any thickness within the range can be chosen to represent any other thickness in the range but the two plates submitted shall be of the same ordered thickness. The average thickness of each test plate shall be determined at the test site by the test agency as indicated in 4.6.2.5.

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4.6.1.7 Heat Affected Zone. Supplier must demonstrate ability to produce plates with edge condition that satisfies 3.2.12.2

4.6.2 Sampling for production acceptance inspection.

4.6.2.1 For chemical analysis. At least one sample for chemical analysis shall be taken from each heat in accordance with the applicable method specified in ASTM A751 (see 6.4).

4.6.2.2 For hardness test.

4.6.2.2.1 Manual method. The Brinell hardness of each plate as heat treated in each lot up to 1.5 inches thick shall be measured in two places, one at each end of a diagonal on one plate surface. The Brinell hardness of each plate as heat treated in each lot over 1.5 inches thick shall be measured in four places, one at each end of a diagonal on both surfaces.

4.6.2.2.2 Image analysis method. Image analysis systems may be used to read the indentation and compute the hardness value and if the heat treating process is continuous (not batch or oscillation), then the amount of testing may be reduced to one surface measurement per plate up to 1.5 inches. Plates over 1.5 inches shall be tested on both surfaces.

4.6.2.3 For Charpy V-notch impact tests. For each lot, at least one sample shall be taken for Charpy V-notch impact tests. This sample shall be extracted from the plate near the ballistic test sample representing the same lot. The sample shall be large enough to obtain at least three specimens, in each direction, from each sample in accordance with 4.8.3.

4.6.2.4 Bend test. Two bend test samples shall be tested in the transverse direction.

4.6.2.5 Ultrasonic examination. All ballistic test plates greater than 0.625 inch in thickness shall be ultrasonically examined in accordance with 4.7.3.

4.6.2.6 For ballistic acceptance samples. Unless otherwise specified in the contract or order (see 6.2), one test plate shall be submitted from each lot. The minimum plate size shall be as shown in Table VI for the applicable thickness. The average thickness of each test plate shall be determined at the test site by taking the average of four thickness measurements. Measurements shall be made at least 1 inch from each edge but preferably at random in the intended impact area. Thickness measurements for plates up to and including 2.750 inch shall be read to the nearest 0.001 inch. Plates over 2.750 inch shall be read to the nearest 0.01 inch. If a producer submits plates outside the specified plate tolerances (see ASTM A6/A6M or Tables III), the procuring activity shall be notified. A Rolled Homogeneous Armor (RHA) Test Data Form (see Figure 1) shall be completed and submitted with each ballistic test plate. In the event that plates of the same heat rolled to a different ordered thickness but with overlapping thickness tolerance ranges can be represented by one ballistic test plate, then only one of the ordered thicknesses need be submitted for acceptance testing. The other ordered thickness, however, shall be included on the applicable reporting form with the words indicating that it is represented by the sample to be tested. However, if the two ordered thicknesses are such that each thickness requires testing with a different type projectile as shown in Table VI, then each of the ordered thicknesses shall be ballistically tested.

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4.7 Examination.

4.7.1 Visual. All steel plate shall be subject to visual inspection for compliance with the requirements for surface conditions (see 3.2.12 .1), edge quality (see 3.2.12.3 and 3.2.12.4) and identification marking (see 3.2.10).

4.7.2 Dimensions. All steel plates shall be subject to inspection for compliance with dimensional and tolerance requirements (3.2.8). Each class 3 armor plate shall divided into one foot squares painted on one surface and the results of each thickness measurement shall be painted in the square in which it was taken.

4.7.3 Ultrasonic examination.

4.7.3.1 Inspection equipment. The ultrasonic soundness inspection equipment shall conform to ASTM A578/A578M.

4.7.3.2 Procedure. Unless otherwise specified (see 6.2), the ultrasonic examination shall be carried out in accordance with ASTM A578/A578M with the following exceptions.

(a) Scanning shall be continuous over 100% of the plate surface.
(b) Scanning rate shall be at a speed where recordable discontinuities can be detected.
(c) The testing frequency shall be a minimum of 2 megahertz (MHz).
(d) Any area within a plate where a discontinuity produces a continuous total loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed within a circle whose diameter is 1 inch shall be cause for rejection of that plate.

4.7.3.3 Certification of inspection personnel. Unless otherwise specified in the contract or purchase order (see 6.2), personnel performing ultrasonic inspection shall comply with the qualification requirements of ISO 9712. Personnel making accept/reject decisions in accordance with the process described by this specification shall be qualified to at least a level II (See 6.3.19).

4.8 Tests.

4.8.1 Chemical analysis. Chemical analysis shall be conducted in accordance with the applicable method specified in ASTM A751 (see 6.4). The analysis shall comply with the declared composition established in accordance with the requirement of Table I (see 3.2.1).

4.8.2 Hardness tests. Brinell hardness tests shall be conducted in accordance with either ASTM E10 or ASTM E110, using a 10 mm carbide ball and a 3000 kilogram load. Surface scale and decarburization shall be removed from the areas where the tests are to be made. However, no more than 0.040 inches shall be removed from the test area. Test area is exempt from thickness tolerance requirement. All hardness readings shall fall within the requirement for the thickness as specified in Table II.

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4.8.2.1 Hardness tests for thin gauge. For plates less than 0.187 inches (4.75 mm) in thickness, a Brinell hardness test shall be conducted in accordance with ASTM E10 using a 5 mm carbide ball and a 750 kilogram load or a 10 mm carbide ball and a 1500 kilogram load.

4.8.2.2 Hardness tests for impact test specimens. Samples for all classifications shall be examined on a lot by lot basis. Except as provided in 4.8.2.2.1, each sample from which impact test specimens are taken shall have a hardness check made upon it as follows: For samples 0.098 to 0.500 inch inclusive at least one hardness check shall be made on the surface. For samples greater than 1/2 inch up to 4 inches (inclusive) in thickness, at least two hardness tests shall be taken from an adjacent location, midway between the surfaces of the plate. For samples of 4 inches in thickness or greater, at least six hardness tests shall be made at equal intervals across the plate thickness.

4.8.2.3 Hardness traverse test. Prior to production to assure compliance to paragraph 3.2.11.2, the size of the heat affected zone for thermally-cut edges shall be determined by taking hardness tests at 1/16 inch increments from the edge. Surface scale and decarburization shall be removed from the test surface. The distance at which there is no change in surface hardness shall be considered the depth of the heat affected zone. The contractor shall document the test results for each thickness and thermal cutting method used in production. The contractor is also responsible for documenting all heat input controls to assure the cutting process is under control. Re-verification of heat affected zone size for subsequent production lots is not required provided there is no change in the cutting method or heat input from that previously tested. The records shall be available for review by the cognizant government representative.

4.8.3 Charpy V-notch impact tests. Three (3) Charpy V-notch impact test specimens per direction for a total of six (6) Charpy V-notch impact specimens shall be taken from the sample and shall be prepared and tested in accordance with ASTM E23 and ASTM A370. Charpy V-notch impact test specimens shall be taken in both the transverse (TL) orientation and longitudinal (LT) orientation from each sample as obtained in accordance with 4.8.3.1 or 4.8.3.2, and shall be prepared and tested in accordance with ASTM E23 and A370. The largest attainable sub-size Charpy V-notch impact test specimens shown in Figure 7 of ASTM E23 shall be used.

4.8.3.1 For samples less than 4 inches in thickness. Charpy V-notch impact test specimens from samples less than 4 inches in thickness shall be taken in both the transverse (TL) orientation and longitudinal (LT) orientation (see 3.2.7.2) from a location midway between the top and bottom surfaces of the plate and at least 4 inches or 2T, whichever is less, from any quenched edge as well as outside the heat-affected zone of any thermally-cut edge. When the amount of materials available is insufficient to obtain standard specimens, the largest attainable sub-size Charpy V-notch impact specimens shown in Figure 4 of ASTM E23 shall be used and the results compared to the applicable requirements of Table IV. There are no Charpy V-notch impact test requirements for plates less than 0.140 inches thick.

4.8.3.2 For sample 4 inches or greater in thickness. Charpy V-notch impact test specimens from samples 4 inches or greater in thickness shall be taken in both the transverse (TL) orientation and longitudinal (LT) orientation approximately 1 inch below the surface of the plate and at least 4 inches from any quenched edge as well as outside the heat-affected zone of any thermally-cut edge.

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4.8.4 Bend test. Bend test samples shall be tested in the transverse direction per ASTM E290, at room temperature through an included angle of 90 degrees (unrestrained) to the inside radii shown in Table V.

4.8.5 Decarburization tests. At least one decarburization test sample shall be taken on each plate selected for the ballistic tests for plates with an ordered thickness of 0.500 inch and less (see 4.6.1.4). ASTM E1077 shall be used to ensure that the depth of decarburization does not exceed 0.017 inch.

4.8.6 Ballistic tests. Ballistic testing of armor plate shall be conducted at a Government approved test facility specified in 4.2.1, unless otherwise specified in the contract or purchase order (see 6.2). Testing shall be conducted in accordance with the requirements of the Appendix A.

4.9 Reduced testing. At the discretion of the procuring activity, the amount of testing shall be reduced provided the results on consecutive lots indicate that a satisfactory uniform product meeting the testing requirements is being produced (see 6.2). Reduced testing shall be in accordance with a system previously approved or established by the procuring activity involved.

4.10 Rejection and retest.

4.10.1 Rejection. Unless otherwise specified in the contract or order (see 6.2), failure of the first article samples to meet the requirements of this specification shall be cause for rejection of the process, and failure of the acceptance samples to meet the requirements of this specification shall be cause for rejection of the lot (see 4.10.2).

4.10.2 Retest. Unless specific retest procedure is specified in the contract or order (see 6.2), two retest samples shall be submitted for each failed sample. Failure of either of the retest samples (plates) shall be cause for rejection of the material. First article retests shall not be permitted until the supplier has made the necessary correction in the processing of the material to the satisfaction of the procuring activity.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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6.1 Intended use. The armor specified herein is intended for use on combat vehicles and/or proof and acceptance testing of armor defeating ammunition, but should also be applicable to armor for emplacements, shields, pill boxes, testing, and the like.

6.1.1 Class 1. Class 1 wrought armor plate is intended for use in those areas where maximum resistance to penetration by armor piercing types of ammunition is required. Please note that MIL-DTL-46177, entitled, "Armor, Steel Plate and Sheet, Wrought, Homogeneous (1/8 to less than 1/4 inch thick)" was incorporated into this document for new design. MIL-DTL-46177C has been in-activated for new designs; therefore, legacy designs/items (contracts/drawings) which used MIL-DTL-46177C in the past can continue to use MIL-DTL-46177C. The current thickness of this specification was even further reduced to 0.098 inches.

6.1.2 Class 2. Class 2 wrought armor plate is intended for use in those areas where maximum resistance to failure under conditions of high rates of shock loading is required and where resistance to penetration by armor piercing ammunition is of secondary importance. It is intended for use as protection against anti-tank land mines, hand grenades, bursting shells, and other blast-producing weapons.

6.1.3 Class 3. Class 3 wrought armor plate is intended for use in the proof and acceptance testing of armor defeating ammunition. This class is not intended for use in combat vehicles. Lift hole requirements for Class 3 armor should be specified by the procuring activity.

6.1.4 Class 4a. Class 4a wrought armor plate has the same maximum carbon content as the other classes, but is tempered at lower temperatures (in Stage I) to give higher hardness. This higher hardness gives the armor enhanced resistance to ballistic penetration.

6.1.5 Class 4b. Class 4b wrought armor has the same maximum carbon content as the other classes, but is tempered at lower temperatures (in Stage I) to give higher hardness. This higher hardness gives the armor enhanced resistance to ballistic penetration. Class 4b has air hardening ability which may lend itself to applications requiring heat treatment after fabrication by forming or other operations.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number and date of this specification.
b. Specify ordered thickness (see 1.1 and 3.2.8.1) and classification (see 1.2).
c. If first article samples are required (see 3.1, 4.4, and 4.4.2).
d. If the declared chemistry composition can be different (see 3.2.1).
e. If an analysis of Antimony, Arsenic or Lead is required (see 3.2.1)
f. If a CE limit for Class 3 material, is required (see 3.2.2.2).
g. If a different CE is required for Class 4a material (see (3.2.2.3).
h. If a CE limit for Class 4b material, is required (see 3.2.2.4).
i. If the condition of the plates is different (see 3.2.4 and 3.2.11.1).
j. If descaling is required (see 3.2.4).
k. If weld repair is not permitted (see 3.2.5.3.1 and 3.2.5.3.2).
l. If a bend test is not required for material less than 1/2 inch in thickness (see 3.2.6.3).
m. If a bend test is required for material greater than 1/2 inch in thickness (see 3.2.6.3 and Table V).
n. If visual inspection requirement is different (see 3.2.6.3).

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o. Specify dimensions (see 3.2.8.1).
p. If dimensional tolerances can be other than that specified in Table III (see 3.2.8.1).
q. Specify thickness tolerances for plates greater than 168 inches in width (see 3.2.8.2.2).
r. If the flatness tolerance is different than those specified (see 3.2.8.3).
s. If tighter flatness tolerance requirements are to be specified (see 3.2.8.3).
t. If the waviness tolerance is different than those specified (see 3.2.8.4).
u. If inspection for surface imperfections is required (see 3.2.11.1.1).
v. If the limits specified for heat affected zone need to be exceeded (see 3.2.11.2).
w. Specify the acceptance level for internal soundness if other than Level C as defined in ASTM A578/A578M (see 3.2.11.4)
x. If someone other than the contractor is responsible for the performance of all the requirements of the specification (see 4.2).
y. If the contractor can't use his own facility or any other facility for testing (see 4.2).
z. If the ballistic tests are to be conducted at another location (see 4.2.1 and 4.8.6).
aa. If production and ballistic test plates can be heat treated separately (see 4.3).
ab. If the number of test plates per lot for ballistic acceptance testing is different (see 4.6.2.6).
ac. If ultrasonic examination is to be different (see 4.7.3.2).
ad. If certification of inspection personnel is different (see 4.7.3.3).
ae. Specify reduced testing plan when applicable (see 4.9).
af. If rejection requirements differ (see 4.10.1).
ag. If retest requirements differ (see 4.10.2).
ah. Packaging requirements (see 5.1).
ai. If definition of a crack is different (see 6.3.18)

6.3 Definitions.

6.3.1 Contractor. The contractor or prime contractor is the company which has a direct contract from the Government to furnish an end item, usually a vehicle.

6.3.2 Contracting officer. The term "contracting officer' means the person executing a contract on behalf of the Government and any other officer or civilian employee who is properly designated contracting officer; and the term includes, except as otherwise provided, the authorized representative of a contracting officer acting within the limits of his or her authority.

6.3.3 Rolled homogeneous armor. Rolled homogeneous armor is armor having uniform composition heat treatment.

6.3.4 Manufacturer. The manufacturer is defined as the company producing the steel alloy plate.

6.3.5 Procuring activity. The term "procuring activity" is that activity of the Government which actually initiates the request for procurement and maintains the records of the procurement.

6.3.6 Slivers. An imperfection consisting of a very thin elongated piece of metal attached by only one end to the parent metal into whose surface it has been worked.

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6.3.7 Laps. A surface imperfection with appearance of a seam caused by hot metal, fins or sharp corners being folded over and thus being forged or rolled into the surface but without being welded.

6.3.8 Checks. Checks are numerous very fine cracks at the surface of a metal part. Checks may appear during processing or during service and are most often associated with thermal cycling or thermal treatment. They are also called check marks, checking, and heat checks.

6.3.9 Seams. A seam is an un-welded fold or lap that appears as a crack, usually resulting from a discontinuity on a metal surface.

6.3.10 Blisters. A raised area, often dome shaped, resulting from delamination under pressure of expanding gas trapped in a metal in a near sub-surface zone. Very small blisters may be called pinhead blisters or pepper blisters.

6.3.11 Snakes. Any crooked surface imperfection in a metal plate, resembling a snake.

6.3.12 Cold shuts. Freezing of the top surface of an ingot before mold is full.

6.3.13 Burning. Burning is permanently damaged metal due to overheating enough to cause incipient melting or intergranular oxidations. Note: this condition is usually obscured by normal cleaning methods and would require deep pickling and/or metallography to note the continuous oxidation (chicken wire effect) of the enlarged grain boundaries.

6.3.14 Lamination. A type of discontinuity with separation or weakness generally aligned parallel to direction of the worked surface of the metal and may be the result of pipe, blisters, seams, inclusions, or segregation; elongated and made directional by working.

6.3.15 Pit. A pit is a cavity or depressed area on the surface of a plate.

6.3.16 Linear indication. For nondestructive examination purposes, a linear indication is evidence of a discontinuity that requires interpretation to determine its significance.

6.3.17 Thickness. The symbol “T” is used throughout this specification to indicate the nominal thickness of the plate under consideration.

6.3.18 Crack. A crack is a planar discontinuity in the metal that has length and is at least 0.002 inch deep. Cracks may be surface cracks or through cracks. For the purposes of this specification, a crack is identifiable by the unaided eye unless otherwise specified in the contract or purchase order (see 6.2).

6.3.19 Level II certification, as defined by ISO 9712. A Level II individual should be capable of demonstrating competence to perform non-destructive testing according to established procedures. Within the scope of the competence defined on the certificate, Level II personnel may be authorized by their employer to:

a) Select the NDT technique for the test method to be used,
b) Define the limitations of application of the testing method,

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c) Translate NDT codes, standards, specifications and procedures into NDT instructions adapted to the actual working conditions,
d) Set up and verify equipment settings,
e) Perform and supervise tests,
f) Interpret and evaluate results according to applicable codes, standards, specifications or procedures,
g) Prepare NDT instructions,
h) Carry out and supervise all tasks at or below Level II,
i) Provide guidance for personnel at or below Level II, and
j) Report the results of non-destructive tests.

6.4 Chemical analysis. Suggested ASTM instrumental methods that can be used for chemical analysis are E322 and E415. ASTM A751 should be consulted for a complete list of methods.

6.4.1 Changes in composition. Changes in composition may not necessarily be cause for retesting but should be subject to review by the procuring activity to determine whether additional first article testing is required.

6.4.2 Changes from prior chemical analysis requirements. The compositions of elements antimony, arsenic, lead, or zirconium are not required in the chemical composition report.

6.5 Special first article ballistic test. Special first article ballistic tests are required when the manufacturer changes either the melting procedure or heat treatment or the declared chemistry of the armor.

6.6 Production plates. Material made to this specification has a tendency to develop stress cracks if not tempered as soon as possible after austenitizing treatment. To avoid this situation all plates should be left in the hot rolled or tempered condition while waiting for the ballistic test results.

6.7 Potential suppliers. Potential suppliers who have not previously supplied armor plate to MIL-DTL-12560 and wish to have their material ballistic tested may do so at their own expense. It is recommended that inquiries for such testing be directed to Commander, USA ATC, ATTN: TEDT-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059. The armor manufacturing process should be inspected by a cognizant government representative to ensure compliance with the details of this specification.

6.8 New contracts sponsored by Government agencies. At the time that a new contract is initiated for the production of combat vehicles, the contractor's supplier is to estimate the number, size and delivery schedule of the ballistic test plates which are to be submitted for first article or acceptance testing. A lead time of 60 days after the contract has been signed is to be allowed prior to shipment of the first ballistic test plate(s) to APG to insure that all administrative functions for the establishment of a new ATC project have been completed in preparation for the test. The contracting government agency is to initiate the new project through a letter to Commander, USA ATC, ATTN: TEDT-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059 requesting a cost estimate for the ballistic testing of the applicable number of sizes of plates. In the case of increases in scope of existing projects, similar correspondence is needed.

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6.9 Fabrication. The armor plate covered by this specification is subject to fabrication involving cutting, drilling, forming and welding. It is intended that selection and control of chemical composition, cleanliness, and plate processing should be such that the armor will be suitable for fabrication in accordance with TACOM code 12479550, TACOM Ground Combat Vehicle Welding Code-Steel. Copies of this document are available from U.S. Army Tank-Automotive and Armaments Command, Warren, MI 48397-6000.

6.10 Forming. Cold forming after the final quenching and tempering operations may be performed if dye penetrant or magnetic particle inspection of the formed area finds it to be free of linear indications. The supplier should practice such necessary process controls to prevent this condition.

6.11 Metric units. When metric dimensions are required, units for inch, foot, foot-pounds and feet per second may be converted to the metric equivalent by multiplying them by the following conversion factors listed in Table VII.

TABLE VII. Conversion factors.

English	Multiply by	Equals	Metric SI unit
inch	0.0254	=	meter (m)
foot	0.3048	=	meter (m)
pound	0.4536	=	kilogram (kg)
foot-lb	1.3558	=	joule (j)
feet/sec	0.3048	=	meter per second (m/s)
Fahrenheit (°F)	(t°F - 32)/1.8 = t°C		Centigrade (°C)

Note: Conversion factors can be associated with ASTM E380 entitled “Metric Practice Guide.”

6.12 Subject term (key word) listing.

Ballistic limit
Ballistic plate
Bend test
M70 projectile
M318 projectile
M602 projectile
M82 projectile
M2 projectile

6.13 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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APPENDIX A

BALLISTIC TESTING OF ARMOR, STEEL PLATE, WROUGHT, HOMOGENEOUS

A.1 SCOPE

A.1.1 This appendix covers the requirements for ballistic testing of wrought homogeneous steel armor plate.

A.2 DEFINITIONS

A.2.1 Fair impact.

A.2.1.1 Caliber .30 AP through 20 mm tests. A fair impact is an impact resulting from the striking of the test plate by a projectile in normal flight (no excessive yawing or tumbling) and separated from another impact or the edge of the plate, hole, crack or spalled area by an undisturbed area at least two test projectile diameters.

A.2.1.2 57 mm AP and larger calibers. A fair impact is an impact resulting from the striking of the test plate by a projectile in normal flight (no yawing or tumbling) and separated from another impact or from the edge of plate, hole, crack or spalled area by at least one test projectile diameter of undisturbed area.

A.2.2 Witness plate. A witness plate is normally a 0.014 inch thick sheet of 5052 aluminum alloy (or a 0.020 inch thick sheet of 2024-T3 aluminum alloy placed 6 inches (+ 1/2 inch) behind and parallel to the test plates or other ballistic sample.

A.2.3 Complete penetration, protection, CP (P).

A.2.3.1 For caliber .30 M2 AP through 20 mm M602 API-T. A protection complete penetration occurs when the projectile or one or more fragments of a projectile or plate pass beyond the back of the test plate and perforates the witness plate.

A.2.3.2 For projectiles larger than 20 mm. A protection complete penetration occurs when one or more fragments of a projectile or plate have been ejected from the rear of the plate as determined by visual inspection.

A.2.4 Partial penetration, protection, PP (PI). A partial penetration is any impact that is not a complete penetration.

A.2.5 Gap. A gap is the difference in velocity between the high partial penetration velocity and the low complete penetration velocity used in computing the ballistic limit where the high partial penetration velocity is lower than the low complete penetration velocity.

A.2.6 Protection ballistic limit, BL (P).

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A.2.6.1 Caliber .30 M2 AP caliber .50 M2 AP, 20 mm M602 APIT penetration tests. The BL (P) shall consist of an equal number of fair impact complete and partial penetration velocities attained by the up-and-down firing method. All BL (P)'s shall be computed using the highest partial penetration velocities and the lowest complete penetration velocities. Firing shall continue until either a 4 round BL (P) having a maximum velocity spread of 60 ft/sec or a 6 round BL (P) having a maximum velocity spread of 90 ft/sec has been attained, whichever comes first in the normal sequence of firing. If both occur simultaneously, the 6 round BL (P) shall be reported.

A.2.6.1.1 Difference between the high partial penetration velocity and the low complete penetration. In the event that the zone of mixed results (difference between the high partial penetration velocity and the low complete penetration velocity, the PP (P) velocity being higher than the low CP (P) velocity) exceeds 90 ft/sec, the firing data shall be compared with the specification minimum ballistic requirements. If the lowest complete penetration velocity is equal to or above the minimum specified ballistic limit velocity for the plate thickness, the ballistic limit shall be computed on the basis of 4 or 6 rounds using the smallest possible velocity spread. If the lowest complete penetration velocity is below the minimum allowable ballistic limit velocity then testing shall continue until a ten round ballistic limit has been attained using the smallest possible velocity spread.

A.2.6.2 57 mm M70 AP and larger caliber projectiles. For the purpose of this specification, the protection ballistic limit is the average of four fair protection criteria impact velocities comprising the first two lowest velocities in the firing order resulting in complete penetrations and the first two highest velocities in the firing order resulting in partial penetrations which meet the condition that the velocity spread for the 4 rounds shall not exceed 100 ft/sec.

A.2.6.3 Reduction of large velocity gap in borderline cases. If the ballistic limit which has been determined is within ± 10 ft/sec from the minimum allowable ballistic limit and a gap exists which is greater than 25 ft/sec, then another round, or rounds, shall be fired to reduce the gap to 25 ft/sec or less. The ballistic limit shall then be recomputed using the criteria of paragraphs A.2.6.1 or A.2.6.2 as applicable. The recomputed BL (P) shall be reported as the BL (P) of the plate. In borderline cases a reduction of the gap between the high partial penetration velocity and the low complete velocity shall result in a better evaluation of the BL (P).

A.3 REQUIREMENTS

A.3.1 Resistance to penetration. The minimum acceptable ballistic limits shall be in accordance with the values shown in Tables A-I through A-VIII.

A.3.1.1 Class 3 armor plate. For class 3 armor plate, upper ballistic limit (maximum) values shall be in accordance with the values shown in Tables A-III through A-VIII.

A.3.2 Back spalling.

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A.3.2.1 Plates 1/2 to 11/16 inch in thickness. Plates of these ordered thicknesses shall be subjected to a back spall test consisting of firing two rounds of 20 mm M95 AP ammunition at a 0° obliquity at the test plate, the striking velocity shall be in the velocity range of 2500-2550 ft/sec. The maximum allowable back spall dimension shall be 1 5/8 inches.

A.3.2.2 Plates 3/4 inch and greater in thickness. Spalling shall not exceed 2.0 test projectile diameters after proof firing at normal obliquity in accordance with the appropriate table of the appendix, and shall not exceed 2.5 test projectile diameters in the case of oblique penetration tests.

A.3.3 Cracking.

A.3.3.1 0° obliquity attack. Immediately after ballistic testing, plates subject to 0° obliquity attack shall not develop any crack which, when measured from the center of impact, extends outside a circle having a radius equivalent to twice the test projectile diameter.

A.3.3.2 Oblique attack. Immediately after ballistic testing, plates subjected to oblique attack shall not develop any crack which when measured from the center of impact, extends outside a circle having a radius equivalent to twice the test projectile diameters.

A.3.4 Rejection. Failure to meet any of the above requirements shall be cause for plate rejection.

A.4 TESTS

A.4.1 Ballistic tests. V_{50} ballistic tests shall be performed in accordance with USATECOM TOP 2-2-710, Ballistic Tests of Armor Materials to determine compliance with the requirements of Tables A-I through A-VIII.

A.4.1.1 Plate thickness. Plate thickness as measured by the ballistic test agency shall be used to determine the required ballistic limit of the plate. The required ballistic limit shall be determined by interpolation of the tables in the appendix, if necessary.

A.4.1.2 Lift hole requirement for test plates.

A.4.1.2.1 Ballistic acceptance testing plates.

a. Ballistic acceptance test plates for either class 1 or 3 armor which are less that 2.751 inches ordered thicknesses are to be supplied without a lifting hole.
b. Ballistic acceptance test plates for either class 1 or 3 armor which are 2.751 inches through 6.25 inches thick shall be provided with 3-inch diameter lifting holes, one in each of two adjacent sides as shown in Figure A-1.

A.4.1.3 Rejection and retest of ballistic plates.

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A.4.1.3.1 First article tests (rejection). Unless noted otherwise in the contract or order, failure of any one or more of the three first article test plates to meet the minimum ballistic requirements as specified in the appendix to the specification indicates failure of the products and process.

A.4.1.3.2 First article (retests). Resubmission of ballistic retest plates shall not be made until the manufacturer has made the necessary corrections in the processing of the material to the satisfaction of the procuring activity. Three retest plates shall be submitted for first article testing and all three shall pass.

A.4.1.3.3 Acceptance tests (rejection). Unless otherwise noted in the contract or order, failure of a test plate to meet the ballistic requirement indicates failure of the lot; however, the final decision shall depend on the outcome of retests, if submitted.

A.4.1.3.4 Acceptance tests (retests). If a test plate representing a lot fails to meet the ballistic requirement, the manufacturer has the following options: Immediately upon notification of the failure:

(1) At manufacturer's expense submit two additional test plates from the same lot for ballistic retest, or
(2) First re-heat treat (quenching and tempering) the lot and then submit a test plate from the re-treated lot, or
(3) Scrap the lot and submit a plate representing a new lot for acceptance.

If the manufacturer chooses any one of these options and the ballistic retest plate (or plates) meet the requirements then the lot represented is acceptable. If he chooses option (1) and one or both the retest plates fail, the manufacturer shall re-heat treat the lot and submit a test plate from the re-treated lot. If this plate fails the lot is rejected. If the manufacturer chooses option (3) and the test plate fails, the manufacturer shall again resort to any one of the three options.

A.4.1.4 Disposition of ballistic test plates.

A.4.1.4.1 First article test plates. Upon request of the applicant within 15 days after ballistic testing, first article plates shall be returned "as is" to the applicant, at the applicant's expense, unless the plates were destroyed in testing.

A.4.1.4.2 Acceptance test plates. Acceptance test plates that comply with the requirements of this specification are considered as part of the lot of steel they represent and ownership of them passes to the Government with the acceptance of that lot. Acceptance test plates that fail to comply with the requirements of this specification are considered as part of the lot they represent and remain the property of the producer just as the rejectable lot does. The failed plates shall be returned, upon request, as in A.4.1.4.1

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TABLE A-I. Minimum required V50 ballistic limits (protection criteria) for class 1 & 4 armor, firing obliquity: 30°; projectile: caliber .30 M2 ball.

Thickness, inches	Required BL(P), ft/sec **CLASS 1 & 4**	Thickness, inches	Required BL(P), ft/sec **CLASS 1 & 4**	Thickness, inches	Required BL(P), ft/sec **CLASS 1 & 4**
0.087	1455	0.120	1762	0.153	2071
0.088	1464	0.121	1771	0.154	2080
0.089	1473	0.122	1781	0.155	2090
0.090	1482	0.123	1790	0.156	2099
0.091	1491	0.124	1799	0.157	2109
0.092	1500	0.125	1809	0.158	2118
0.093	1509	0.126	1818	0.159	2127
0.094	1519	0.127	1828	0.160	2137
0.095	1528	0.128	1837	0.161	2141
0.096	1537	0.129	1846	0.162	2146
0.097	1546	0.130	1856	0.163	2151
0.098 1/	1556	0.131	1865	0.164	2156
0.099	1565	0.132	1874	0.165	2161
0.100	1574	0.133	1884	0.166	2166
0.101	1584	0.134	1893	0.167	2171
0.l02	1593	0.135	1903	0.168	2176
0.103	1603	0.136	1912	0.169	2180
0.104	1612	0.137	1921	0.170	2185
0.105	1622	0.138	1931	0.171	2190
0.106	1631	0.139	1940	0.172	2195
0.107	1640	0.140	1949	0.173	2200
0.108	1650	0.141	1959	0.174	2204
0.109	1659	0.142	1968	0.175	2209
0.110	1668	0.143	1977	0.176	2214
0.111	1678	0.144	1987	0.177	2219
0.112	1687	0.145	1996	0.178	2224
0.113	1696	0.146	2006	0.179	2228
0.114	1706	0.147	2015	0.180	2233
0.115	1715	0.148	2024	0.181	2238
0.116	1725	0.149	2034	0.182	2242
0.117	1734	0.150	2043	0.183	2247
0.118	1743	0.151	2052	0.184	2252
0.119	1753	0.152	2062	0.185	2257

1/ Specification requirements begin for this ordered thickness

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-I. Minimum required V50 ballistic limits (protection criteria) for class 1 and 4 armor, firing obliquity: 30°; projectile: caliber .30 M2 ball. (Continued)

Thickness, inches	Required BL(P), ft/sec **CLASS 1 & 4**	Thickness, inches	Required BL(P), ft/sec **CLASS 1 & 4**
0.186	2261	0.215	2393
0.187	2266	0.216	2398
0.188	2271	0.217	2402
0.189	2275	0.218	2407
0.190	2280	0.219	2411
0.191	2285	0.220	2416
0.192	2289	0.221	2420
0.193	2294	0.222	2424
0.194	2298	0.223	2428
0.195	2303	0.224	2433
0.196	2308	0.225	2437
0.197	2312	0.226	2441
0.198	2317	0.227	2446
0.199	2321	0.228	2450
0.200	2326	0.229	2454
0.201	2330	0.230 2/	2459
0.202	2335	0.231	2463
0.203	2339	0.232	2467
0.204	2344	0.233	2472
0.205	2348	0.234	2476
0.206	2353	0.235	2480
0.207	2357	0.236	2484
0.208	2362	0.237	2489
0.209	2366	0.238	2493
0.210	2371	0.239	2497
0.211	2375	0.240	2501
0.212	2380	0.241	2506
0.213	2384	0.242	2510
0.214	2389	0.243	2514

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-II. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: caliber .30 M2 AP.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
0.205	1386 1/	N/A	0.355	1994	2135	0.505	2456	2597
0.210	1411 1/	N/A	0.360	2011	2152	0.510	2470	2611
0.215	1435 1/	N/A	0.365	2028	2169	0.515	2484	2625
0.220	1458 1/	N/A	0.370	2045	2186	0.520	2498	2639
0.225	1482	1623	0.375	2062	2203	0.525	2512	2653
0.231 2/	1509	1650	0.380	2078	2219	0.530	2525	2666
0.235	1532	1673	0.385	2095	2236	0.535	2539	2680
0.240	1554	1695	0.390	2111	2252	0.540	2552	2693
0.245	1575	1716	0.395	2127	2268	0.545	2566	2707
0.250 3/	1596	1737	0.400	2143	2284	0.550	2579	2720
0.255	1618	1759	0.405	2159	2300	0.555	2593	2734
0.260	1638	1779	0.410	2175	2316	0.560	2606	2747
0.265	1659	1800	0.415	2191	2332	0.565	2619	2760
0.270	1679	1820	0.420	2206	2347	0.570	2632	2773
0.275	1699	1840	0.425	2222	2363	0.575	2645	2786
0.280	1719	1860	0.430	2237	2378	0.580	2658	2799
0.285	1739	1880	0.435	2252	2393	0.585	2671	2812
0.290	1758	1899	0.440	2267	2408	0.590	2684	2825
0.295	1778	1919	0.445	2282	2423	0.595	2697	2838
0.300	1797	1938	0.450	2297	2438	0.600	2710	2851
0.305	1815	1956	0.455	2312	2453	0.605	2723	2864
0.310	1834	1975	0.460	2327	2468	0.610	2736	2877
0.315	1853	1994	0.465	2342	2483	0.615	2749	2890
0.320	1871	2012	0.470	2356	2497	0.620	2762	2903
0.325	1889	2030	0.475	2371	2512	0.624 4/	2772	2913
0.330	1907	2048	0.480	2385	2526	0.625	2775	2916
0.335	1925	2066	0.485	2400	2541	0.630	2788	2929
0.340	1942	2083	0.490	2414	2555	0.635	2801	2942
0.345	1960	2101	0.495	2428	2569	0.640	2814	2955
0.350	1977	2118	0.500	2442	2583	0.645	2827	2968

1/ Values only apply to Class 1

2/ Specification requirements begin for this ordered thickness for Class 1.

3/ Specification requirements begin for this ordered thickness for Class 3.

4/ Specification requirements end for this ordered thickness for Classes 1 & 3.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-III. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: caliber .50 M2 AP.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
0.550	1901	2047	0.695	2182	2328	0.845	2439	2585
0.555	1911	2057	0.700	2191	2337	0.850	2447	2593
0.560	1922	2068	0.705	2200	2346	0.855	2455	2601
0.565	1932	2078	0.710	2209	2355	0.860	2464	2610
0.566	1934	2080	0.715	2218	2364	0.865	2472	2618
0.570	1942	2088	0.720	2227	2373	0.870	2480	2626
0.575	1952	2098	0.725	2235	2381	0.875	2488	2634
0.580	1962	2108	0.730	2244	2390	0.880	2496	2642
0.585	1972	2118	0.735	2253	2399	0.885	2504	2650
0.590	1982	2128	0.740	2262	2408	0.890	2511	2657
0.595	1992	2138	0.745	2271	2417	0.895	2519	2665
0.600	2002	2148	0.750	2279	2425	0.900	2527	2673
0.605	2012	2158	0.755	2288	2434	0.905	2535	2681
0.610	2022	2168	0.760	2297	2443	0.910	2543	2689
0.615	2031	2177	0.765	2305	2451	0.915	2551	2697
0.620	2041	2187	0.770	2314	2460	0.920	2559	2705
0.625 1/	2051	2197	0.775	2322	2468	0.925	2566	2712
0.630	2060	2206	0.780	2331	2477	0.930	2574	2720
0.635	2070	2216	0.785	2339	2485	0.935	2582	2728
0.640	2079	2225	0.790	2348	2494	0.940	2590	2736
0.645	2089	2235	0.795	2356	2502	0.945	2597	2743
0.650	2098	2244	0.800	2365	2511	0.950	2605	2751
0.655	2108	2254	0.805	2373	2519	0.955	2612	2758
0.660	2117	2263	0.810	2382	2528	0.960	2620	2766
0.665	2126	2272	0.815	2390	2536	0.965	2628	2774
0.670	2136	2282	0.820	2398	2544	0.970	2635	2781
0.675	2145	2291	0.825	2406	2552	0.975	2643	2789
0.680	2154	2300	0.830	2415	2561	0.980	2650	2796
0.685	2163	2309	0.835	2423	2569	0.985	2658	2804
0.690	2173	2319	0.840	2431	2577	0.990	2665	2811

1/ Specification requirements begin for this ordered thickness

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-III. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: caliber .50 M2 AP- Continued.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
0.995	2673	2819	1.065	2775	2921	1.135	2874	3020
1.000	2680	2826	1.070	2782	2928	1.140	2881	3027
1.005	2688	2834	1.075	2790	2936	1.145	2888	3034
1.010	2695	2841	1.080	2797	2943	1.150	2895	3041
1.015	2702	2848	1.085	2804	2950	1.155	2902	3048
1.020	2710	2856	1.090	2811	2957	1.160	2909	3055
1.025	2717	2863	1.095	2818	2964	1.165	2915	3061
1.030	2724	2870	1.100	2825	2971	1.170	2922	3068
1.035	2732	2878	1.105	2832	2978	1.175	2929	3075
1.040	2739	2885	1.110	2839	2985	1.180	2936	3082
1.045	2746	2892	1.115	2846	2992	1.185	2943	3089
1.050	2754	2900	1.120	2853	2999	1.190	2949	3095
1.055	2761	2907	1.125 2/	2860	3006	1.195	2956	3102
1.060	2768	2914	1.130	2867	3013	1.200	2963	3109

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-IV. Minimum required ballistic limits (protection criteria) for class 1, 3 and 4 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 20 mm M602 API-T.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1, 3 & 4 Min	3 Max		1, 3 & 4 Min	3 Max		1, 3 & 4 Min	3 Max
1.080	1909	2016	1.400	2265	2403	1.730	2586	2748
1.090	1921	2029	1.410	2275	2414	1.740	2595	2758
1.100	1933	2042	1.420	2285	2425	1.750	2604	2768
1.110	1945	2055	1.430	2295	2436	1.760	2613	2778
1.120	1957	2068	1.440	2305	2447	1.770	2613	2787
1.126 [1/]	1964	2076	1.450	2315	2458	1.780	2621	2797
1.130	1969	2081	1.460	2325	2469	1.790	2630	2807
1.140	1981	2094	1.470	2335	2480	1.800	2639	2816
1.150	1993	2106	1.480	2344	2491	1.810	2647	2826
1.160	2004	2119	1.490	2354	2501	1.820	2656	2836
1.170	2016	2131	1.500	2364	2512	1.830	2664	2845
1.180	2027	2144	1.510	2374	2523	1.840	2673	2855
1.190	2039	2156	1.520	2383	2534	1.850	2681	2864
1.200	2050	2169	1.530	2393	2544	1.860	2690	2874
1.210	2061	2181	1.540	2403	2555	1.870	2698	2883
1.220	2073	2193	1.550	2412	2565	1.880	2707	2892
1.230	2084	2205	1.560	2422	2576	1.890	2715	2902
1.240	2095	2217	1.570	2431	2586	1.900	2723	2911
1.250	2106	2229	1.580	2440	2597	1.910	2732	2921
1.260	2117	2241	1.590	2450	2607	1.920	2740	2930
1.270	2128	2253	1.600	2459	2617	1.930	2748	2939
1.280	2139	2265	1.610	2468	2628	1.940	2757	2948
1.290	2149	2277	1.620	2478	2638	1.950	2765	2958
1.300	2160	2289	1.630	2487	2648	1.960	2773	2967
1.310	2171	2300	1.640	2496	2658	1.970	2781	2976
1.320	2181	2312	1.650	2505	2668	1.980	2789	2985
1.330	2192	2323	1.660	2514	2678	1.990	2798	2994
1.340	2203	2335	1.670	2524	2689	2.000	2806	3003
1.350	2213	2346	1.680	2533	2699	2.010	2814	3012
1.360	2223	2358	1.690	2542	2709	2.020	2822	3021
1.370	2234	2369	1.700	2551	2719	2.030	2830	3030
1.380	2244	2380	1.710	2560	2728	2.040	2838	3039
1.390	2254	2392	1.720	2568	2738	2.050	2846	3048

[1/] Specification requirements begin for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-IV. Minimum required ballistic limits (protection criteria) for class 1, 3 and 4 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 20 mm M602 API-T. Continued.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1, 3 & 4 Min	3 Max		1, 3 & 4 Min	3 Max		1, 3 & 4 Min	3 Max
2.060	2854	3057	2.320	3052	3282	2.580	3238	3493
2.070	2862	3066	2.330	3060	3290	2.590	3245	3501
2.080	2870	3075	2.340	3067	3298	2.600	3252	3509
2.090	2877	3084	2.350	3075	3307	2.610	3259	3516
2.100	2885	3093	2.360	3082	3315	2.620	3265	3524
2.110	2893	3102	2.370	3089	3323	2.630	3272	3532
2.120	2901	3110	2.380	3096	3331	2.640	3279	3540
2.130	2909	3119	2.390	3104	3340	2.650	3286	3548
2.140	2916	3128	2.400	3111	3348	2.660	3293	3556
2.150	2924	3137	2.410	3118	3356	2.670	3299	3563
2.160	2932	3145	2.420	3125	3364	2.680	3306	3571
2.170	2940	3154	2.430	3132	3372	2.690	3313	3579
2.180	2947	3163	2.440	3140	3381	2.700	3320	3586
2.190	2955	3171	2.450	3147	3389	2.710	3326	3594
2.200	2963	3180	2.460	3154	3397	2.720	3333	3602
2.210	2970	3188	2.470	3161	3405	2.730	3340	3610
2.220	2978	3197	2.480	3168	3413	2.740	3346	3617
2.230	2985	3206	2.490	3175	3421	2.750 2/	3353	3625
2.240	2993	3214	2.500	3182	3429	2.760	3360	3632
2.250	3000	3223	2.510	3189	3437	2.770	3366	3640
2.260	3008	3231	2.520	3196	3445	2.780	3373	3648
2.270	3015	3240	2.530	3203	3453	2.790	3380	3655
2.280	3023	3248	2.540	3210	3461	2.800	3386	3663
2.290	3030	3257	2.550	3217	3469	2.810	3393	3670
2.300	3038	3265	2.560	3224	3477	2.820	3400	3678
2.310	3045	3273	2.570	3231	3485	2.830	3406	3686

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-V. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 45°, projectile: caliber 90 mm M82 APC.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
2.690	2089	2382	2.980	2260	2553	3.280	2425	2718
2.700	2095	2388	2.990	2265	2558	3.290	2430	2723
2.710	2101	2394	3.000	2271	2564	3.300	2436	2729
2.720	2107	2400	3.010	2277	2570	3.310	2441	2734
2.730	2113	2406	3.020	2282	2575	3.320	2446	2739
2.740	2119	2412	3.030	2288	2581	3.330	2451	2744
2.750	2125	2418	3.040	2294	2587	3.340	2457	2750
2.751 1/	2126	2419	3.050	2299	2592	3.350	2462	2755
2.760	2131	2424	3.060	2305	2598	3.360	2467	2760
2.770	2137	2430	3.070	2310	2603	3.370	2472	2765
2.780	2143	2436	3.080	2316	2609	3.380	2478	2771
2.790	2149	2442	3.090	2322	2615	3.390	2483	2776
2.800	2155	2448	3.100	2327	2620	3.400	2488	2781
2.810	2161	2454	3.110	2333	2626	3.410	2493	2786
2.820	2167	2460	3.120	2338	2631	3.420	2498	2791
2.830	2173	2466	3.130	2344	2637	3.430	2504	2797
2.840	2179	2472	3.140	2349	2642	3.440	2509	2802
2.850	2185	2478	3.150	2355	2648	3.450	2514	2807
2.860	2190	2483	3.160	2360	2653	3.460	2519	2812
2.870	2196	2489	3.170	2366	2659	3.470	2524	2817
2.880	2202	2495	3.180	2371	2664	3.480	2529	2822
2.890	2208	2501	3.190	2376	2669	3.490	2534	2827
2.900	2214	2507	3.200	2382	2675	3.500 2/	2540	2833
2.910	2220	2513	3.210	2387	2680	3.510	2545	2838
2.920	2225	2518	3.220	2393	2686	3.520	2550	2843
2.930	2231	2524	3.230	2398	2691	3.530	2555	2848
2.940	2237	2530	3.240	2404	2697	3.540	2560	2853
2.950	2243	2536	3.250	2409	2702	3.550	2565	2858
2.960	2248	2541	3.260	2414	2707	3.560	2570	2863
2.970	2254	2547	3.270	2420	2713	3.570	2575	2868

1/ Specification requirements begin for this ordered thickness.

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VI. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 30°, projectile: 90 mm M82 APC.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
3.425	1924	2116	3.570	1986	2178	3.720	2048	2240
3.430	1926	2118	3.575	1988	2180	3.725	2051	2243
3.435	1929	2121	3.580	1990	2182	3.730	2053	2245
3.440	1931	2123	3.585	1993	2185	3.735	2055	2247
3.445	1933	2125	3.590	1995	2187	3.740	2057	2249
3.450	1935	2127	3.595	1997	2189	3.745	2059	2251
3.455	1937	2129	3.600	1999	2191	3.750	2061	2253
3.460	1939	2131	3.605	2001	2193	3.755	2063	2255
3.465	1942	2134	3.610	2003	2195	3.760	2065	2257
3.470	1944	2136	3.615	2005	2197	3.765	2067	2259
3.475	1946	2138	3.620	2007	2199	3.770	2069	2261
3.480	1948	2140	3.625	2009	2201	3.775	2071	2263
3.485	1950	2142	3.630	2011	2203	3.780	2073	2265
3.490	1952	2144	3.635	2013	2205	3.785	2075	2267
3.495	1954	2146	3.640	2015	2207	3.790	2077	2269
3.500	1957	2149	3.645	2018	2210	3.795	2079	2271
3.501 [1/]	1957	2149	3.650	2020	2212	3.800	2081	2273
3.505	1959	2151	3.655	2022	2214	3.805	2083	2275
3.510	1961	2153	3.660	2024	2216	3.810	2085	2277
3.515	1963	2155	3.665	2026	2218	3.815	2087	2279
3.520	1965	2157	3.670	2028	2220	3.820	2089	2281
3.525	1967	2159	3.675	2030	2222	3.825	2091	2283
3.530	1969	2161	3.680	2032	2224	3.830	2093	2285
3.535	1971	2163	3.685	2034	2226	3.835	2095	2287
3.540	1974	2166	3.690	2036	2228	3.840	2097	2289
3.545	1976	2168	3.695	2038	2230	3.845	2099	2291
3.550	1978	2170	3.700	2040	2232	3.850	2101	2293
3.555	1980	2172	3.705	2042	2234	3.855	2103	2295
3.560	1982	2174	3.710	2044	2236	3.860	2105	2297
3.565	1984	2176	3.715	2046	2238	3.865	2107	2299

[1/] Specification requirements begin for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VI. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 30°,projectile: 90 mm M82 APC – Continued.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
3.870	2109	2301	3.940	2137	2329	4.005	2162	2354
3.875	2111	2303	3.945	2139	2331	4.010	2164	2356
3.880	2113	2305	3.950	2141	2333	4.015	2166	2358
3.885	2115	2307	3.955	2143	2335	4.020	2168	2360
3.890	2117	2309	3.960	2144	2336	4.025	2170	2362
3.895	2119	2311	3.965	2146	2338	4.030	2172	2364
3.900	2121	2313	3.970	2148	2340	4.035	2174	2366
3.905	2123	2315	3.975	2150	2342	4.040	2176	2368
3.910	2125	2317	3.980	2152	2344	4.045	2178	2370
3.915	2127	2319	3.985	2154	2346	4.050	2179	2371
3.920	2129	2321	3.990	2156	2348	4.055	2181	2373
3.925	2131	2323	3.995	2158	2350	4.060	2183	2375
3.930	2133	2325	3.999 2/	2160	2352	4.065	2185	2377
3.935	2135	2327	4.000	2160	2352	4.070	2187	2379

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VII. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 90 mm M318A1 AP.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
3.940	1583	1785	4.260	1697	1899	4.580	1805	2007
3.950	1586	1788	4.270	1701	1903	4.590	1808	2010
3.960	1590	1792	4.280	1704	1906	4.600	1811	2013
3.970	1594	1796	4.290	1708	1910	4.610	1815	2017
3.980	1597	1799	4.300	1711	1913	4.620	1818	2020
3.990	1601	1803	4.310	1714	1916	4.630	1821	2023
4.000 1/	1605	1807	4.320	1718	1920	4.640	1824	2026
4.010	1608	1810	4.330	1721	1923	4.650	1827	2029
4.020	1612	1814	4.340	1725	1927	4.660	1831	2033
4.030	1616	1818	4.350	1728	1930	4.670	1834	2036
4.040	1619	1821	4.360	1731	1933	4.680	1837	2039
4.050	1623	1825	4.370	1735	1937	4.690	1840	2042
4.060	1627	1829	4.380	1738	1940	4.700	1844	2046
4.070	1630	1832	4.390	1742	1944	4.710	1847	2049
4.080	1634	1836	4.400	1745	1947	4.720	1850	2052
4.090	1637	1839	4.410	1748	1950	4.730	1853	2055
4.100	1641	1843	4.420	1752	1954	4.740	1856	2058
4.110	1644	1846	4.430	1755	1957	4.750	1860	2062
4.120	1648	1850	4.440	1758	1960	4.760	1863	2065
4.130	1652	1854	4.450	1762	1964	4.770	1866	2068
4.140	1655	1857	4.460	1765	1967	4.780	1869	2071
4.150	1659	1861	4.470	1768	1970	4.790	1872	2074
4.160	1662	1864	4.480	1772	1974	4.800	1875	2077
4.170	1666	1868	4.490	1775	1977	4.810	1878	2080
4.180	1669	1871	4.500	1778	1980	4.820	1882	2084
4.190	1673	1875	4.510	1782	1984	4.830	1885	2087
4.200	1676	1878	4.520	1785	1987	4.840	1888	2090
4.210	1680	1882	4.530	1788	1990	4.850	1891	2093
4.220	1683	1885	4.540	1792	1994	4.860	1894	2096
4.230	1687	1889	4.550	1795	1997	4.870	1897	2099
4.240	1690	1892	4.560	1798	2000	4.880	1900	2102
4.250	1694	1896	4.570	1801	2003	4.890	1903	2105

1/ Specification requirements begin for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VII. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°,projectile: 90 mm M318A1 AP – Continued.

Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
4.900	1907	2109	5.230	2006	2208	5.560	2102	2304
4.910	1910	2112	5.240	2009	2211	5.570	2105	2307
4.920	1913	2115	5.250	2012	2214	5.580	2107	2309
4.930	1916	2118	5.260	2015	2217	5.590	2110	2312
4.940	1919	2121	5.270	2018	2220	5.600	2113	2315
4.950	1922	2124	5.280	2021	2223	5.610	2116	2318
4.960	1925	2127	5.290	2024	2226	5.620	2119	2321
4.970	1928	2130	5.300	2027	2229	5.630	2121	2323
4.980	1931	2133	5.310	2030	2232	5.640	2124	2326
4.990	1934	2136	5.320	2033	2235	5.650	2127	2329
5.000	1937	2139	5.330	2036	2238	5.660	2130	2332
5.010	1940	2142	5.340	2039	2241	5.670	2133	2335
5.020	1943	2145	5.350	2042	2244	5.680	2135	2337
5.030	1946	2148	5.360	2045	2247	5.690	2138	2340
5.040	1950	2152	5.370	2047	2249	5.700	2141	2343
5.050	1953	2155	5.380	2050	2252	5.710	2144	2346
5.060	1956	2158	5.390	2053	2255	5.720	2147	2349
5.070	1959	2161	5.400	2056	2258	5.730	2149	2351
5.080	1962	2164	5.410	2059	2261	5.740	2152	2354
5.090	1965	2167	5.420	2062	2264	5.750	2155	2357
5.110	1968	2170	5.430	2065	2267	5.760	2158	2360
5.110	1971	2173	5.440	2068	2270	5.770	2160	2362
5.120	1974	2176	5.450	2070	2272	5.780	2163	2365
5.130	1977	2179	5.460	2073	2275	5.790	2166	2368
5.140	1980	2182	5.470	2076	2278	5.800	2169	2371
5.150	1983	2185	5.480	2079	2281	5.810	2171	2373
5.160	1986	2188	5.490	2082	2284	5.820	2174	2376
5.170	1989	2191	5.500	2085	2287	5.830	2177	2379
5.180	1992	2194	5.510	2088	2290	5.840	2180	2382
5.190	1995	2197	5.520	2090	2292	5.850	2182	2384
5.200	1998	2200	5.530	2093	2295	5.860	2185	2387
5.210	2001	2203	5.540	2096	2298	5.870	2188	2390
5.220	2003	2205	5.550	2099	2301	5.880	2190	2392

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VII. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 90 mm M318A1 AP – Continued.

Thickness, inches	BL(P), ft/sec C LASS		Thickness, inches	BL(P), ft/sec CLASS		Thickness, inches	BL(P), ft/sec CLASS	
	1 & 3 Min	3 Max		1 & 3 Min	3 Max		1 & 3 Min	3 Max
5.890	2193	2395	5.950	2209	2411	6.010	2226	2428
5.900	2196	2398	5.960	2212	2414	6.020	2228	2430
5.910	2199	2401	5.970	2215	2417	6.030	2231	2433
5.920	2201	2403	5.980	2217	2419	6.040	2234	2436
5.930	2204	2406	5.990	2220	2422	6.050	2236	2438
5.940	2207	2409	6.000 2/	2223	2425	6.060	2239	2441

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VIII. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: caliber .30 FSP.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.087	1102	0.120	1489	0.153	1875
0.088	1114	0.121	1500	0.154	1887
0.089	1125	0.122	1512	0.155	1899
0.090	1137	0.123	1524	0.156	1911
0.091	1149	0.124	1536	0.157	1922
0.092	1160	0.125	1547	0.158	1934
0.093	1172	0.126	1559	0.159	1946
0.094	1184	0.127	1571	0.160	1958
0.095	1196	0.128	1582	0.161	1969
0.096	1207	0.129	1594	0.162	1981
0.097	1219	0.130	1606	0.163	1993
0.098 1/	1231	0.131	1618	0.164	2004
0.099	1242	0.132	1629	0.165	2016
0.100	1254	0.133	1641	0.166	2028
0.101	1266	0.134	1653	0.167	2040
0.l02	1278	0.135	1664	0.168	2051
0.103	1289	0.136	1676	0.169	2063
0.104	1301	0.137	1688	0.170	2075
0.105	1313	0.138	1700	0.171	2086
0.106	1325	0.139	1711	0.172	2098
0.107	1336	0.140	1723	0.173	2110
0.108	1348	0.141	1735	0.174	2122
0.109	1360	0.142	1747	0.175	2133
0.110	1371	0.143	1758	0.176	2145
0.111	1383	0.144	1770	0.177	2157
0.112	1395	0.145	1782	0.178	2169
0.113	1407	0.146	1793	0.179	2180
0.114	1418	0.147	1805	0.180	2192
0.115	1430	0.148	1817	0.181	2204
0.116	1442	0.149	1829	0.182	2215
0.117	1453	0.150	1840	0.183	2227
0.118	1465	0.151	1852	0.184	2239
0.119	1477	0.152	1864	0.185	2251

1/ Specification requirements begin for this ordered thickness

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VIII. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: caliber .30 FSP - Continued.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.186	2262	0.215	2602	0.244	2942
0.187	2274	0.216	2614	0.245	2954
0.188	2286	0.217	2626	0.246	2966
0.189	2297	0.218	2637	0.247	2977
0.190	2309	0.219	2649	0.248	2989
0.191	2321	0.220	2661	0.249 2/	3001
0.192	2333	0.221	2673	0.250	3013
0.193	2344	0.222	2684	0.251	3024
0.194	2356	0.223	2696	0.252	3036
0.195	2368	0.224	2708	0.253	3048
0.196	2380	0.225	2719	0.254	3059
0.197	2391	0.226	2731	0.255	3071
0.198	2403	0.227	2743	0.256	3083
0.199	2415	0.228	2755	0.257	3095
0.200	2426	0.229	2766	0.258	3106
0.201	2438	0.230	2778	0.259	3118
0.202	2450	0.231	2790	0.260	3130
0.203	2462	0.232	2802	0.261	3141
0.204	2473	0.233	2813	0.262	3153
0.205	2485	0.234	2825	0.263	3165
0.206	2497	0.235	2837	0.264	3177
0.207	2508	0.236	2848	0.265	3188
0.208	2520	0.237	2860	0.266	3200
0.209	2532	0.238	2872	0.267	3212
0.210	2544	0.239	2884	0.268	3223
0.211	2555	0.240	2895	0.269	3235
0.212	2567	0.241	2907	0.270	3247
0.213	2579	0.242	2919	0.271	3259
0.214	2591	0.243	2930	0.272	3270

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-IX. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: caliber .50 FSP.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.230	1730	0.340	2466	0.450	3202
0.235	1763	0.345	2499	0.455	3235
0.240	1797	0.350	2532	0.460	3268
0.245	1830	0.355	2566	0.465	3302
0.250 1/	1864	0.360	2599	0.470	3335
0.255	1897	0.365	2633	0.475	3369
0.260	1930	0.370	2666	0.480	3402
0.265	1964	0.375	2700	0.485	3436
0.270	1997	0.380	2733	0.490	3469
0.275	2031	0.385	2767	0.495	3503
0.280	2064	0.390	2800	0.499 2/	3529
0.285	2098	0.395	2834	0.500	3536
0.290	2131	0.400	2867	0.505	3569
0.295	2165	0.405	2900	0.510	3603
0.300	2198	0.410	2934	0.515	3636
0.305	2231	0.415	2967	0.520	3670
0.310	2265	0.420	3001	0.525	3703
0.315	2298	0.425	3034	0.530	3737
0.320	2332	0.430	3068	0.535	3770
0.325	2365	0.435	3101	0.540	3804
0.330	2399	0.440	3135	0.545	3837
0.335	2432	0.445	3168	0.550	3871

1/ Specification requirements begin for this ordered thickness

2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-X. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: 20 mm FSP.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.445	1937	0.590	2417	0.740	2914
0.450	1954	0.595	2434	0.745	2931
0.455	1971	0.600	2451	0.750	2947
0.460	1987	0.605	2467	0.755	2964
0.465	2004	0.610	2484	0.760	2980
0.470	2020	0.615	2500	0.765	2997
0.475	2037	0.620	2517	0.770	3013
0.480	2053	0.625	2533	0.775	3030
0.485	2070	0.630	2550	0.780	3047
0.490	2086	0.635	2566	0.785	3063
0.495	2103	0.640	2583	0.790	3080
0.500 1/	2120	0.645	2600	0.795	3096
0.505	2136	0.650	2616	0.800	3113
0.510	2153	0.655	2633	0.805	3129
0.515	2169	0.660	2649	0.810	3146
0.520	2186	0.665	2666	0.815	3162
0.525	2202	0.670	2682	0.820	3179
0.530	2219	0.675	2699	0.825	3196
0.535	2235	0.680	2715	0.830	3212
0.540	2252	0.685	2732	0.835	3229
0.545	2268	0.690	2749	0.840	3245
0.550	2285	0.695	2765	0.845	3262
0.555	2302	0.700	2782	0.850	3278
0.560	2318	0.705	2798	0.855	3295
0.565	2335	0.710	2815	0.860	3311
0.566	2338	0.715	2831	0.865	3328
0.570	2351	0.720	2848	0.870	3345
0.575	2368	0.725	2864	0.875	3361
0.580	2384	0.730	2881	0.880	3378
0.585	2401	0.735	2898	0.885	3394

1/ Specification requirements begin for this ordered thickness

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-X. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: 20 mm FSP - Continued.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.890	3411	0.945	3593	1.000 [2]	3775
0.895	3427	0.950	3609	1.005	3792
0.900	3444	0.955	3626	1.010	3808
0.905	3460	0.960	3643	1.015	3825
0.910	3477	0.965	3659	1.020	3841
0.915	3494	0.970	3676	1.025	3858
0.920	3510	0.975	3692	1.030	3874
0.925	3527	0.980	3709	1.035	3891
0.930	3543	0.985	3725	1.040	3907
0.935	3560	0.990	3742	1.045	3924
0.940	3576	0.995	3758	1.050	3941

[2/] Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-XI. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, projectile: caliber .30 M2 AP.

Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec
0.210	1927	0.265	2329	0.325	2650
0.215	1969	0.270	2359	0.330	2674
0.220	2010	0.275	2389	0.335	2697
0.225	2050	0.280	2418	0.340	2719
0.230	2088	0.285	2447	0.345	2741
0.231 1/	2096	0.290	2474	0.350	2763
0.235	2126	0.295	2501	0.354 2/	2780
0.240	2162	0.300	2527	0.355	2785
0.245	2197	0.305	2553	0.360	2807
0.250	2232	0.310	2578	0.365	2829
0.255	2265	0.315	2603	0.370	2851
0.260	2297	0.320	2627	0.375	2873

1/ Specification requirements begin for this ordered thickness.
2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-XII. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, projectile: caliber .50 M2 AP.

Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec
0.320	1690	0.420	2045	0.520	2400
0.325	1708	0.425	2063	0.525	2418
0.330	1726	0.430	2080	0.530	2435
0.335	1743	0.435	2098	0.535	2453
0.340	1761	0.440	2116	0.540	2471
0.345	1779	0.445	2134	0.545	2489
0.350	1796	0.450	2151	0.550	2506
0.355 1/	1814	0.455	2169	0.555	2524
0.360	1832	0.460	2187	0.560	2542
0.365	1850	0.465	2205	0.565	2560
0.370	1867	0.470	2222	0.570	2577
0.375	1885	0.475	2240	0.575	2595
0.380	1903	0.480	2258	0.580	2613
0.385	1921	0.485	2276	0.585	2631
0.390	1938	0.490	2293	0.590 2/	2648
0.395	1956	0.495	2311	0.595	2666
0.400	1974	0.500	2329	0.600	2684
0.405	1992	0.505	2347	0.605	2702
0.410	2009	0.510	2364	0.610	2719
0.415	2027	0.515	2382	0.615	2737

1/ Specification requirements begin for this ordered thickness.
2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-XIII. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, projectile: 14.5 mm B32 API.

Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec
0.575	2220	0.645	2369	0.720	2521
0.580	2231	0.650	2380	0.725	2530
0.585	2242	0.655	2390	0.730	2540
0.590	2253	0.660	2400	0.735	2550
0.591 1/	2255	0.665	2411	0.740	2559
0.595	2264	0.670	2421	0.745	2569
0.600	2274	0.675	2431	0.750	2579
0.605	2285	0.680	2441	0.755	2588
0.610	2296	0.685	2451	0.760	2598
0.615	2307	0.690	2461	0.765 2/	2607
0.620	2317	0.695	2471	0.770	2617
0.625	2328	0.700	2481	0.775	2626
0.630	2338	0.705	2491	0.780	2636
0.635	2349	0.710	2501	0.785	2645
0.640	2359	0.715	2511	0.790	2654

1/ Specification requirements begin for this ordered thickness.
2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-XIV. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, projectile: 14.5 mm BS41 API.

Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec	Thickness inches	Required BL(P), ft/sec
0.740	2112	0.875	2452	1.015	2765
0.745	2125	0.880	2464	1.020	2775
0.750	2139	0.885	2476	1.025	2786
0.755	2152	0.890	2488	1.030	2796
0.760	2165	0.895	2499	1.035	2807
0.765	2178	0.900	2511	1.040	2817
0.766 1/	2181	0.905	2522	1.045	2827
0.770	2192	0.910	2534	1.050	2838
0.775	2205	0.915	2545	1.055	2848
0.780	2218	0.920	2557	1.060	2858
0.785	2231	0.925	2568	1.065	2868
0.790	2243	0.930	2579	1.070	2879
0.795	2256	0.935	2590	1.075	2888
0.800	2269	0.940	2602	1.080	2898
0.805	2282	0.945	2613	1.085	2908
0.810	2294	0.950	2624	1.090	2918
0.815	2307	0.955	2635	1.095	2927
0.820	2319	0.960	2646	1.100	2936
0.825	2331	0.965	2657	1.105	2946
0.830	2344	0.970	2668	1.110	2956
0.835	2356	0.975	2679	1.115	2965
0.840	2368	0.980	2690	1.120	2975
0.845	2381	0.985	2700	1.125 2/	2984
0.850	2393	0.990	2711	1.130	2994
0.855	2405	0.995	2722	1.135	3003
0.860	2417	1.000	2732	1.140	3012
0.865	2429	1.005	2743	1.145	3022
0.870	2440	1.010	2754	1.150	3031

1/ Specification requirements begin for this ordered thickness.
2/ Specification requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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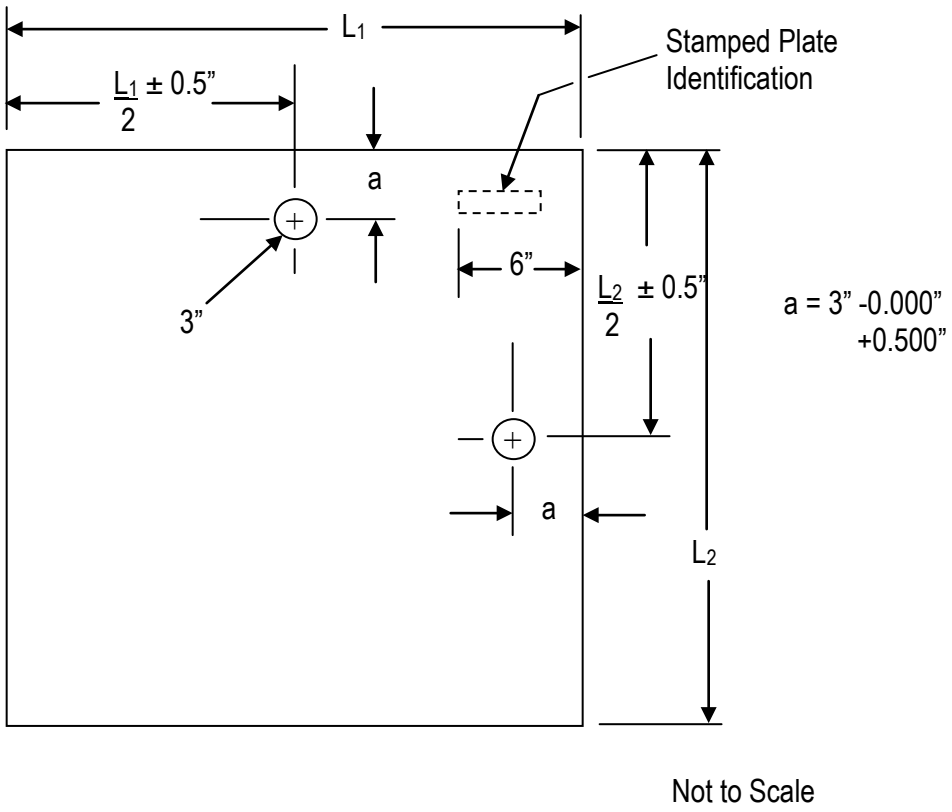

FIGURE A-1. Lifting holes for ballistic acceptance test plates 2.751 through 6.25 inches thick.

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CONCLUDING MATERIAL

Custodian:
Army - MR

Review activities:
Army - AR, AT, AV, TE
DLA - IS

Preparing activity:
Army - MR

Project 9515-2012-001

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